ME3023 Lecture - Chapter 4

Probability and Statistics

<u>Theory and Design for Mechanical Measurements</u>

5th ed. by Richard Figliola and Donald Beasley

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- ## 4.6 - Least Squares Regression Analysis

  - A measured variable is often a function of one or more independent variables that are controlled during the measurement. When the measured variable is sampled, these variables are controlled, to the extent possible, as are all the other operating conditions. Then, one of these variables is changed and a new sampling is made under the new operating conditions. This is a common procedure used to document the relationship between the measured variable and an independent process variable. We can use regression analysis to establish a functional relationship between the dependent variable and the independent variable. This discussion pertains directly to polynomial curve fits.

  - Most spreadsheet and engineering software packages can perform a regression analysis on a data set. The following discussion presents the concepts of a particular type of regression analysis, its interpretation, and its limitations.

– **Consider the graphs below. These are calibration curves.**

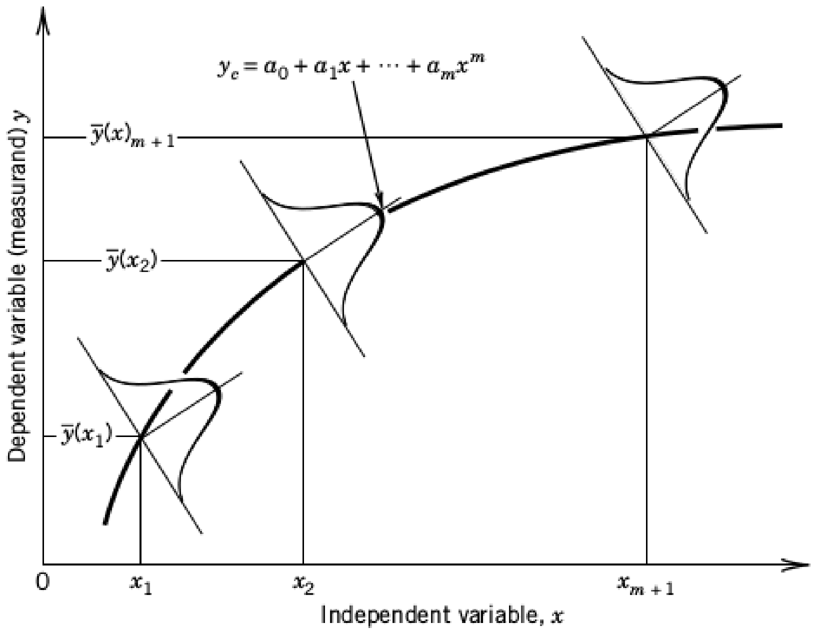

Figure 4.9 Distribution of measured value y about each fixed value of independent variable x. The curve y_c represents a possible functional relationship.

– **Least Squares Regression**

∗ **We are trying to find a polynomial of best fit.**

$$y_c(x) = a_0 + a_1 x + a_2 x^2 + \ldots + a_m x^m \qquad m \leq (n-1)$$

∗ **This is done by minimizing the quantity below.**

$$D = \Sigma_{i=1}^{N}(y_i - y_{ci})^2 = \Sigma_{i=1}^{N}(y_i - a_0 + a_1 x + a_2 x^2 + \ldots + a_m x^m)^2$$

∗ **For a first order curve the coefficients can be solved as follows.**

$$a_0 = \frac{\Sigma x_i \Sigma x_i y_i - \Sigma x_i^2 \Sigma y_i}{(\Sigma x_i)^2 - N \Sigma x_i^2}$$

∗ **and**

$$a_1 = \frac{\Sigma x_i \Sigma y_i - N \Sigma x_i y_i}{(\Sigma x_i)^2 - N \Sigma x_i^2}$$